Renewable Energy Resource Potential Assessment for Manningham City Council – Overview Report

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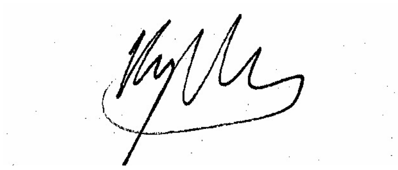
Prepared for Manningham City Council as part of the Carbon Neutral Communities project September, 2008

Version 1.0

Project Director's Approval of Final Report

This report reaches the quality standard set by the Centre for Design, RMIT University, Melbourne, Australia.

Signed



Dr Ralph Horne
Director, Centre for Design

QA Review

Reviewed by	Date
Dr Ralph Horne	23/09/2008

Release and Revision Record

Revision Date	Release/Revision Description	Change Reference

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Key Points

The renewable energy resource potential assessment for Manningham LGA found:

- Currently Manningham LGA produces approximately 11.5% more greenhouse pollutants per person than the Victorian average and 16.5% more than the national average.
- Sufficient renewable energy resource potential exists (ie what can be collected using current technologies considered in this assessment) to meet between 95%-110% of Manningham LGAs total current energy demand (Figure 1). Trends in energy efficiency improvements, population growth, economic structure and economic growth could influence the final energy requirements.
- If all renewable energy from Figure 1 was implemented then 4.3 Mt of carbon emissions would be saved each year (three times as much as is currently produced).
- Solar photovoltaics and hot water systems provide the potential to meet between 61 and 77% of Manningham LGAs total current energy demand.
- Wind turbines provide the potential to meet 34% of Manningham LGAs current energy demand
- 41% of current total energy demand can be provided by renewable energy resources in and financially viable way (Figure 2).
- Solar hot water systems, small wind turbines and biomass are currently economically viable, however solar photovoltaics are not currently economically viable without extra rebates.

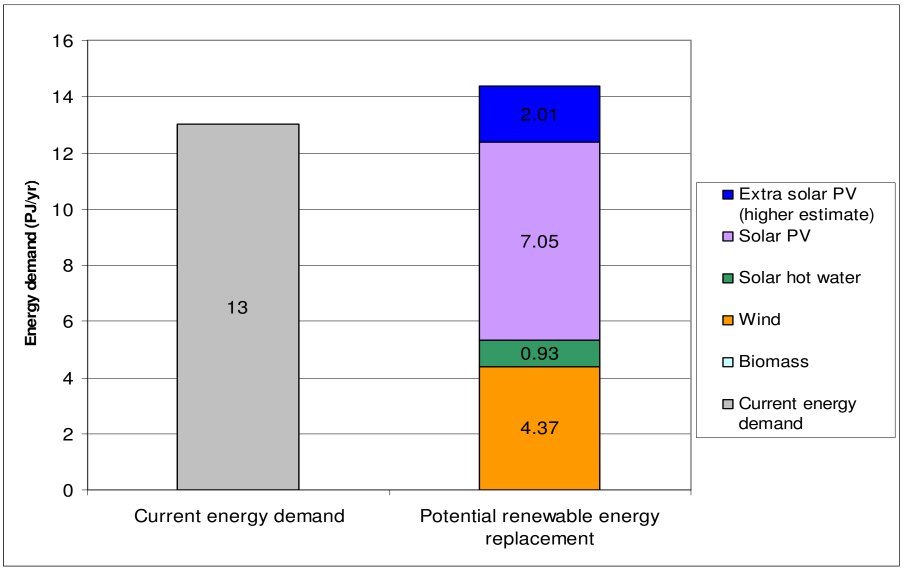

Figure 1: Comparison of current energy demand and potential renewable energy resource replacement for Manningham LGA.

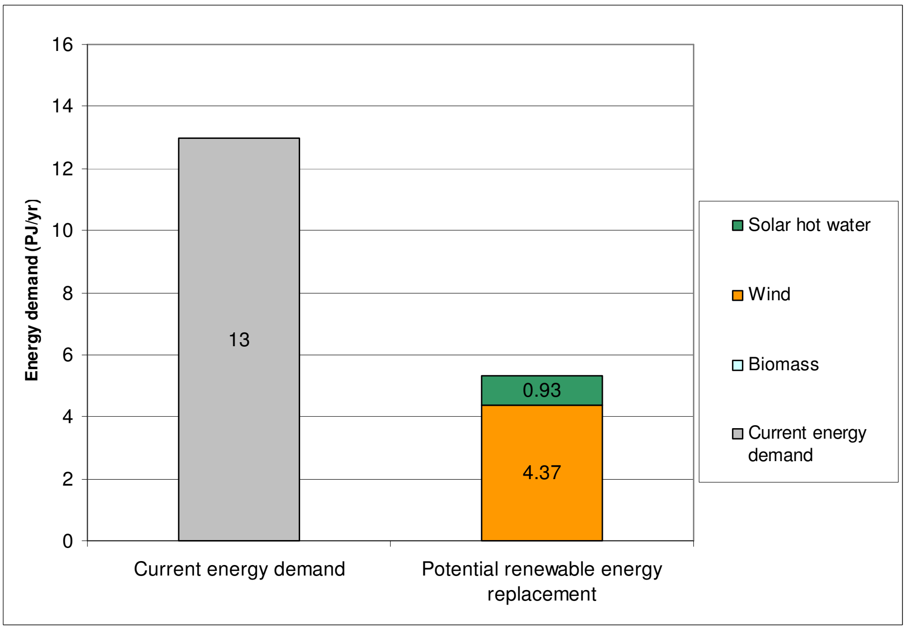

Figure 2: Comparison of current energy demand and potential renewable energy reserve replacement for Manningham LGA.

Potential Renewable Energy Resource Assessment for Manningham City Council

1 Glossary of Terms and Acronyms

ABS	Australian Bureau of Statistics
CNC	Carbon Neutral Community
Climate Change	A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods
GHG	Greenhouse Gases - those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation
GJ	GigaJoule (one billion Joule)
GW	GigaWatt
GWh	GigaWatt-hour (one billion Watt-hours)
IPCC	Intergovernmental Panel on Climate Change
kW	KiloWatt (one thousand Watt)
kWh	KiloWatt-hour (one thousand Watt-hours)
MJ	MegaJoule (one million Joule)
MW	MegaWatt (million Watt)
PJ	PetaJoule (one million GigaJoule)
Solar HW	Solar Hot Water
Solar PV	Solar Photo-voltaic
yr	year

Conversion Factors Used

1 GJ = 277.8 kWh
1 kWh = 3.6 MJ

2 Aim

This report provides an overview of the results from the renewable energy potential assessment for the Manningham City Council local government area (Manningham LGA). A more comprehensive working paper will be prepared alongside this overview and can be referred to for further information.

3 Introduction

3.1 Carbon Neutral Communities (CNC)

Towards Carbon Neutral Communities - Making the Transition is a three year Australian Research Council funded project which began in 2007. The project partners include Manningham City Council (Vic), City of Playford (SA), Northern Alliance for Greenhouse Action (NAGA), ICLEI, Moreland Energy Foundation (MEFL), Community Power and Consumer Affairs Victoria. The project team includes researchers from the University of South Australia and RMIT Centre for Design.

Key phases of the project include:

- Developing method to assess energy use and Greenhouse Gas Emissions;
- exploring the options for energy efficiency and renewable energy in a geographically defined area;
- developing a database of projects focussing on resolving non-technical barriers to carbon neutrality;
- developing an evaluation method for programs;
- action research phase; and
- communication of research results.

More information about the CNC project can be found at the CNC website at www.rmit.edu.au/cnc

3.2 Manningham LGA

In the past few years, issues to do with climate change have come to the forefront of all areas of life. Local governments, such as Manningham City Council, have realised the need for action in this area and are leading by example in developing a range of strategies to address climate change and other environmental issues. Manningham City Council has made a commitment to move towards becoming a more sustainable community by supporting research as an industry partner for projects such as CNC and by developing initiatives, such as the Climate Energy Action Planning Program and others which assist in the transition towards a more sustainable community.

Manningham LGA residents produce approximately 22.01 tonnes of greenhouse gases per person per year (ACF 2008). This is approximately 17% higher than the national average and almost 12% higher than the state average. It is important that Manningham works to reduce its greenhouse gas emissions in order to contribute to limiting climate change impacts.

This report examines the potential for renewable energy technology in Manningham LGA.

3.3 Renewable Energy

There are now many different types of renewable energy technology available to consumers including solar photovoltaics (PV), solar hot water, wind turbines, biomass and hydro electricity. Each of these available renewable energy technologies has its own benefits and limitations. For example, while solar PV has great potential to produce energy during the day, storage factors, can limit its potential to provide energy during non solar productive periods such as during the night. Technology is improving every year to move towards overcoming many of these issues and make renewable energy a much more viable option for replacing fossil fuel energy. An example of this is that solar PVs produce the most energy when facing the sun, so in Victoria when they face north. However this study shows that solar PVs on flat roof space, as well as east and west facing roof space, have the potential to provide significant amounts of energy.

As part of the CNC project, a renewable energy potential assessment was carried out for the City of Playford in South Australia. This assessment calculated the current total energy demand for all sectors in the City of Playford (residential, commercial, industrial, transport, waste and agriculture). The assessment then mapped the potential for different renewable energy technology through the City of Playford by looking primarily at solar photovoltaics (PV), solar hot water, wind turbines and biomass. The end result was an overview of the potential for renewable energy to displace current energy demand. This same assessment was carried out for the Manningham LGA and is the basis of this report. For further information on the City of Playford assessment methodologies and results, a working paper is available on the CNC website at www.rmit.edu.au/cnc

The methodology used here for the Manningham LGA assessment adopted the methodology set out for the City of Playford assessment with a few additional steps. These additional steps give a more accurate reflection of the potential for renewable energy to help reduce carbon emitted through energy demand. A brief overview of the methodology is provided below. A comprehensive methodology is available in a longer working paper.

The types of renewable energy potentially available in the Manningham LGA were solar, wind and biomass. There may be other forms of renewable energy available in the Manningham LGA but they were deemed to be too small in potential to be looked at in this assessment.

4 Methodology

The total energy consumed and carbon emitted was calculated using an average of four different carbon assessment methods. These methods included data from transport, waste and agriculture as well as data from the residential, commercial and industrial sectors. An average across the four methods was taken and used as the current energy demand and carbon emitted levels for Manningham LGA.

The potential renewable energy assessment was carried out for each resource as follows:

Solar -

- Using aerial photos and valuation data, which was supplied by Manningham City Council, the residential data was separated into decade of build (as different decades tend to have different building sizes which leads to differences in available roof space) and each decade was randomly sampled.
- Randomly selected houses in each decade had their available roof area mapped using ArcGIS for their north, east and west facing roof area as well as any flat roof area. Each direction was recorded separately as each direction had different solar radiation values (see Figure 1 for an example).
- Any solar hot water or solar photovoltaic (PV) on buildings was also mapped and recorded as separate data
- Once enough buildings in each decade had been randomly sampled (to a 95% confidence level) the areas for north, west, east and flat were calculated for each of decades and extrapolated to represent the whole of that decade of build. This study differs from the one for the City of Playford by calculating not just the north facing roof area but also the east, west and flat area availability.
- From these total roof areas, the potential for solar hot water and solar PV were calculated. These calculations included calculating the:
    - Amount of solar hot water and solar PV already in use
    - Remaining potential for solar hot water
    - Remaining roof area not used for solar hot water which could be used for solar PV for north, east, west and flat.
- The same method was followed for commercial and industrial buildings although these were not split up into year of build.

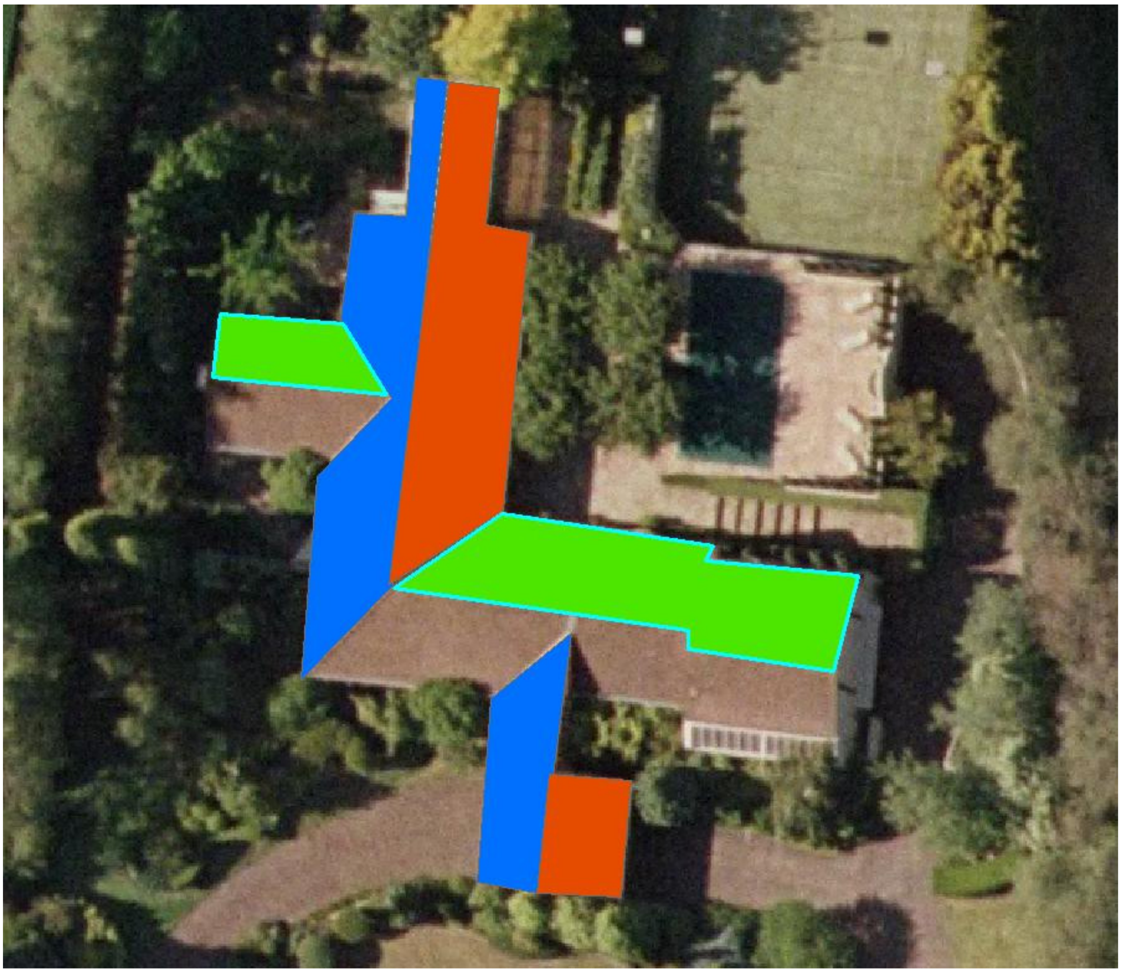

Figure 1: An example of the solar roof mapping. This randomly selected residential building had the different sides mapped for calculating the potential for renewable energy. The different colours represent the different roof directions: green is the north facing roof space, red is the east facing roof space and blue is the west facing roof space. There was no flat roof space in this example.

Wind–

- Five different wind turbines were assessed for their potential for Manningham LGA, two medium to large wind turbines and three small wind turbines.
- The large wind turbine potential was calculated by covering the Manningham LGA with a grid based upon the distance requirements for medium to large wind turbines to be located from each other. From this grid it was assumed that the centre of each grid box was one turbine. Using ArcGIS, potential wind turbines were removed based upon wind turbine setback requirements (such as being 500m from buildings, not being located in certain types of parklands etc). After all these requirements were factored in, the remaining potential sites were inspected on the aerial photo, and using contour data, were removed if the location was further unsuitable (ie near a creek or on a slope). Once all these restrictions had been added, the remaining wind turbine locations were used to calculate the potential for medium to large wind turbine power.
- The small wind turbines were assumed to be able to be placed one per building on a 10m tower and assumed to have no restrictions or setbacks.

Biomass –

- Calculated by using the amount of municipal waste, human biosolids, animal biosolids, agriculture and green waste (garden waste etc) produced each year which could be converted to biomass.

For a more comprehensive methodology please refer to the working paper which accompanies this report.

Results

This following section provides an overview of the key findings from the assessment. The three main renewable energy types which are available in the Manningham LGA are outlined and overall results provided. For a more comprehensive results report, please refer to the working paper (Moore & Hamilton 2008).

For the data used throughout the assessment it was assumed that the area of the Manningham LGA was 114km^2 (MCC 2008) and as at July 2008 the population was estimated to be 116,449 (ABS 2008). The assessment of current energy demand showed that an average of 13 PJ/yr of energy per year is used in the Manningham LGA which equates to approximately 1.41 Mt of carbon dioxide emissions each year. According to research from the Australian Conservation Foundation (ACF 2008), Manningham produces an average of 22.01 tonnes of greenhouse pollution per person per year. This is 11.5% higher than the state average and 16.5% higher than the national average.

4.1 Solar results

Of the 42,051 residential buildings across the Manningham LGA 1189 were sampled (2.83%). Of the 1160 commercial buildings and 145 industrial buildings 312 (27%) and 145 (100%) were sampled respectively (Table 1). Overall 1,646 buildings were assessed for solar capability.

Table 1: Number of properties for the residential, commercial and industrial sectors and how many buildings in each land use were assessed.

Land use	Total No. of properties	No. of properties assessed
Residential	42051	1189 (2.83%)
Commercial	1160	312 (27%)
Industrial	145	145 (100%)

The results showed that there is currently minimal uptake of solar hot water and solar PV systems in the Manningham LGA (Figure 2). Less than 1.5% of buildings in the sample have a solar hot water system and approximately 0.01% had a solar PV system.

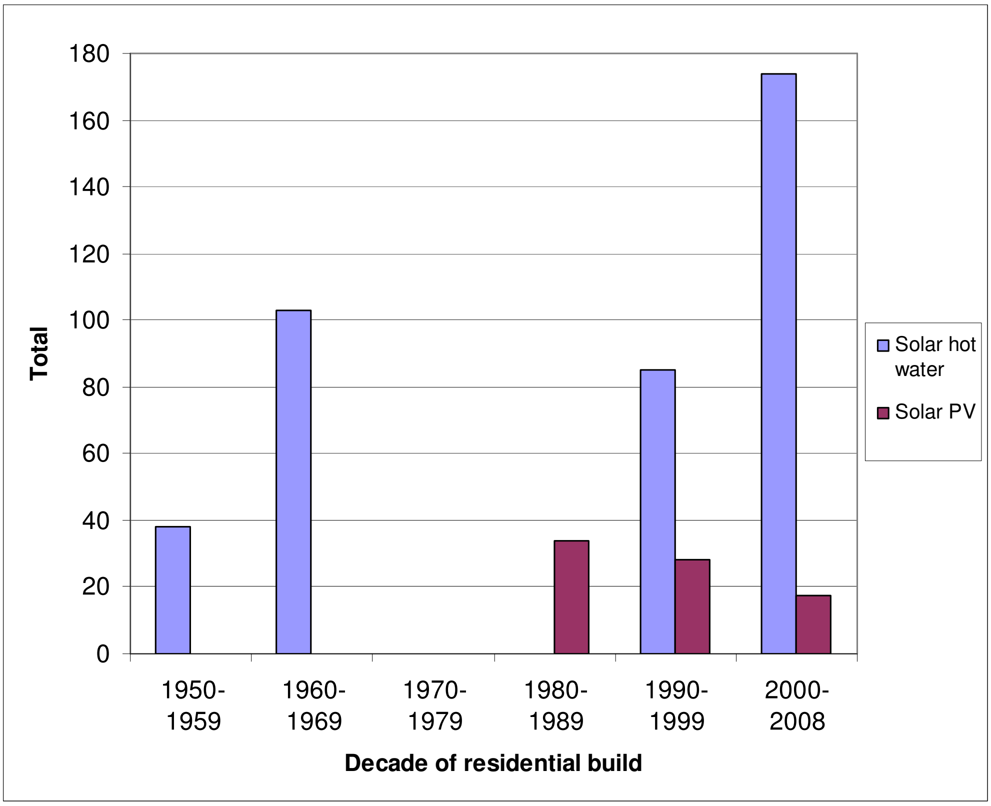

Figure 2: Estimate of total solar hot water systems and solar PV systems currently in Manningham LGA.

There is a significant potential for solar hot water and solar PV to provide energy for the Manningham LGA. Figure 3 shows the breakdown of energy demand that solar hot water and solar PV (by roof direction) can provide. North facing roof area provides about one third of potential solar PV (not including solar hot water). If solar hot water is included, north facing roof area could provide about 44% of total solar energy potential.

Residential buildings provide the greatest potential for solar energy collection. Industrial and commercial buildings can still provide significant solar energy collection, however these buildings tend to have more flat roof area than north facing roof area which leads to a less efficient production of solar energy. One option in overcoming flat roof area efficiency is through the use of frames to optimise the orientation and slope of the solar PV although these are not considered in this assessment.

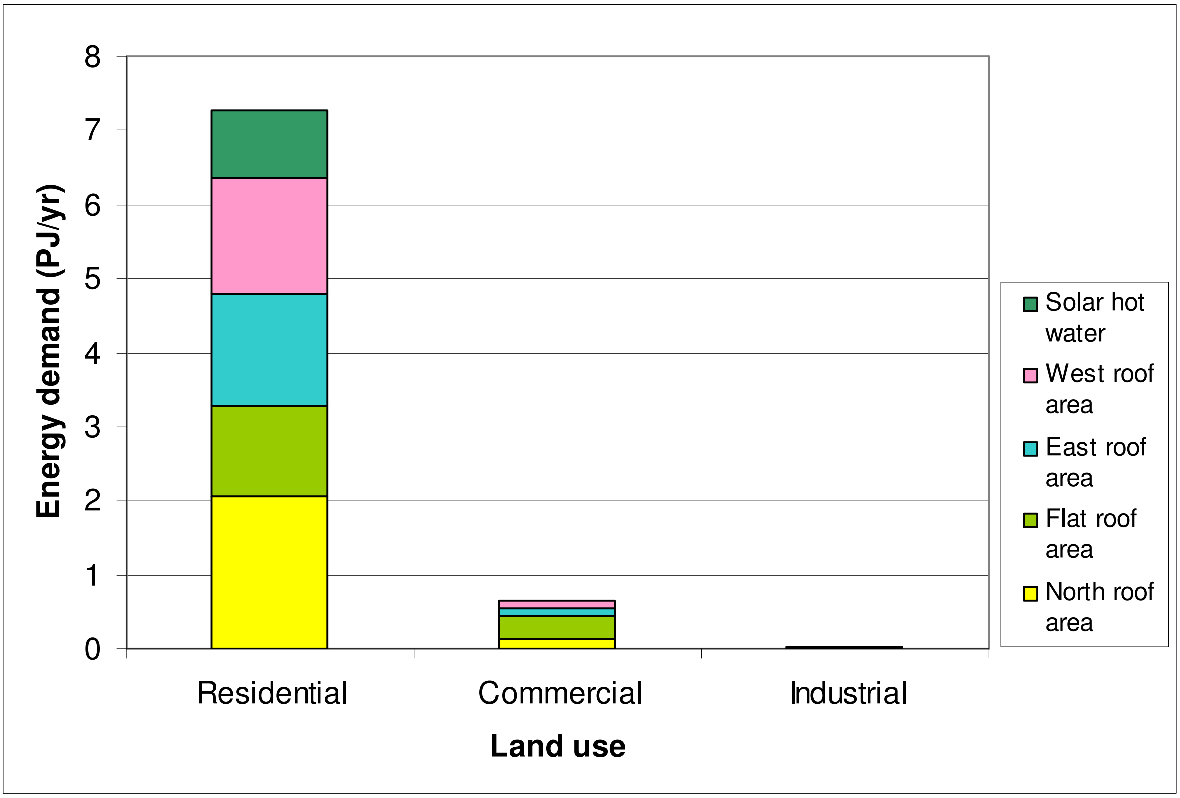

Figure 3: Potential solar PV and hot water on buildings across the three land uses for Manningham LGA.

The results of the solar assessment show that there is significant potential energy able to be produced by solar power (hot water and PV) in the Manningham area. If the combination of north, west, east and flat roof area is used to harvest solar energy, there is the potential to generate 7.98 PJ/yr, which accounts for 61% of Manningham's current total energy demand.

4.2 Wind results

The resource assessment for wind energy potential in Manningham was undertaken using large, medium and small wind turbines. There are a number of factors currently limiting the potential location for large to medium wind turbines. In this study it is assumed such factors cannot be located within 500m of a building, within set distances from roads or located within parkland areas etc. As a result of these limitations there is currently no potential for medium to large wind turbines across Manningham LGA. It is important to note, however, that this is based upon the criteria considered in this assessment and it may not necessarily be conclusive. To make a final assessment based upon the potential to locate large to medium wind turbine across the Manningham area a more in-depth wind survey would need to be carried out to find any potential sites. A more thorough review of current restrictions on location of wind turbines within urban areas would also need to considered in this assessment.

Despite the limitations on using large to medium wind turbines, there is significant energy potential able to be generated from an assessment of three small wind turbines which were located one per building,

Figure 4 shows the potential from all wind turbine types and shows that a 3kw small wind turbine, located one on each building, could provide just under 4.5 PJ/yr of energy or 33% of current total energy demand for Manningham LGA. This equates to just over 50% of the energy potential from solar power. The small wind turbines energy output could not be combined as it is estimated that there would only be room for one per building and so the highest energy output small wind turbine was used.

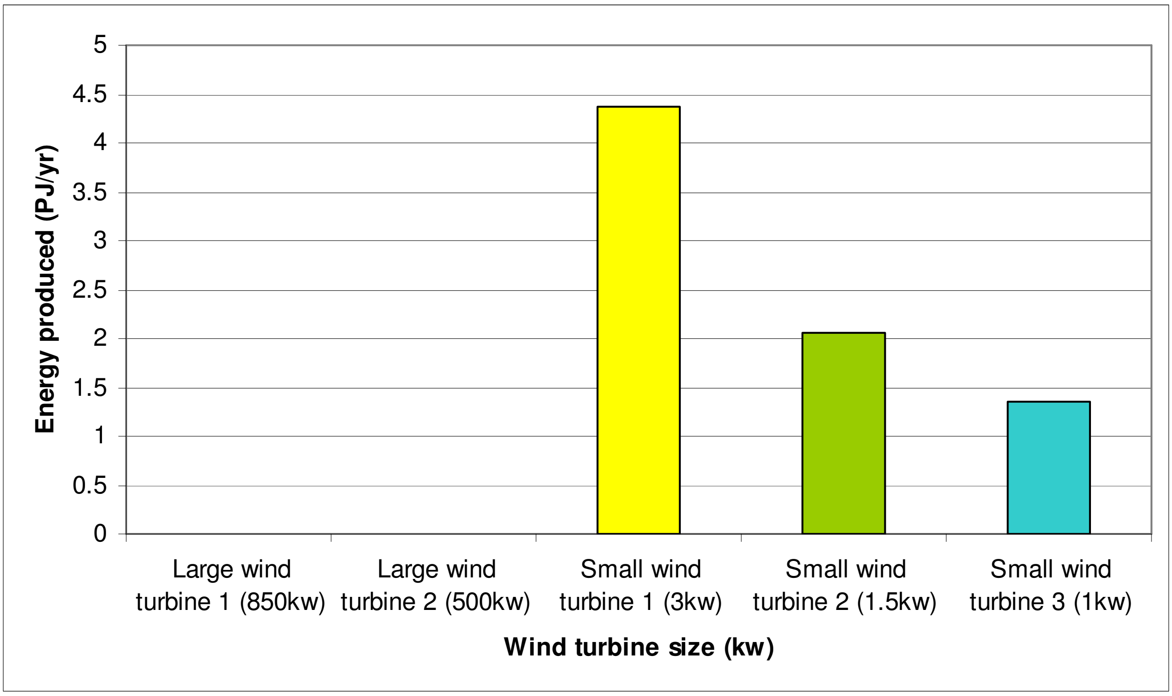

Figure 4: Potential wind energy from 5 different wind turbines for Manningham LGA. Note that the two large wind turbines had no suitable sites and therefore had no potential for energy production.

4.3 Biomass results

The biomass results showed that there was minimal energy potential available from this resource compared to wind and solar. Biomass provided 0.1% of total renewable energy potential for the Manningham LGA. This figure is low due to a number of different factors which include:

- All human waste (sewerage, household waste, green waste etc) is taken outside of the region for treatment and disposal and so can not be claimed for potential biomass use, unless a new facility in Manningham LGA is built.
- Small area for growing crops which could be used for biomass potential.
- No significant suitable farm animals which could have their waste collected and used for biomass potential.
- No significant urban forestry which could be used for biomass potential.

4.4 Overall results

This assessment for the Manningham LGA has shown that there is significant potential to harvest energy from renewable resources. The overall summary of the potential renewable energy resources for Manningham LGA is shown below in Figure 5.

Solar was found to provide almost two thirds of renewable energy potential for Manningham (57% solar PV and 8% solar hot water). Wind provided the remaining 35% through small wind turbines. There was no significant potential for biomass.

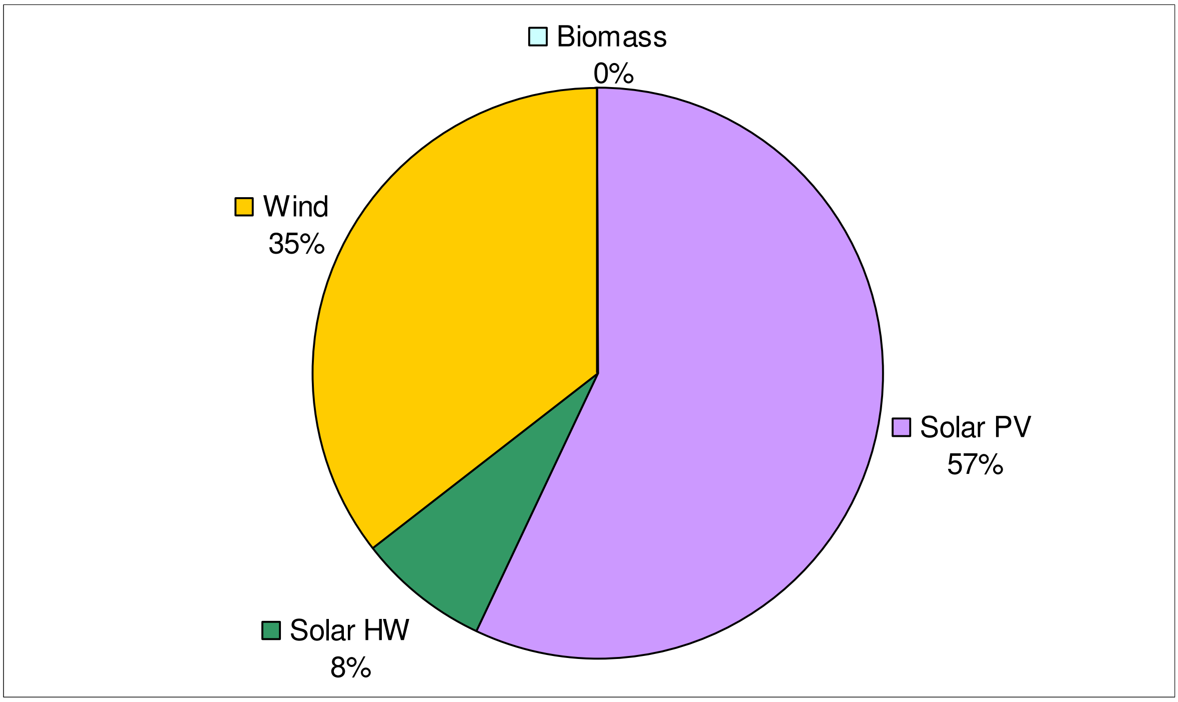

Figure 5: Break down of potential renewable energy resources for Manningham LGA.

Manningham has a current energy demand of 13 PJ/yr. Combining all the renewable energy potential options from this study (Figure 6) has found that a total of 12.36 PJ/yr (95% of total current energy demand) is possible based upon current technologies. This was calculated using a conservative figure for the solar energy calculations. If calculations based upon the USA National Renewable Energy Laboratory were used, which has provided data for Melbourne stating a higher value of PV output can be achieved, a total of 14.37 PJ/yr (110% of total current energy demand for Manningham LGA) is achievable. Figure 7 shows the breakdown of the different renewable energy potentials compared to the total.

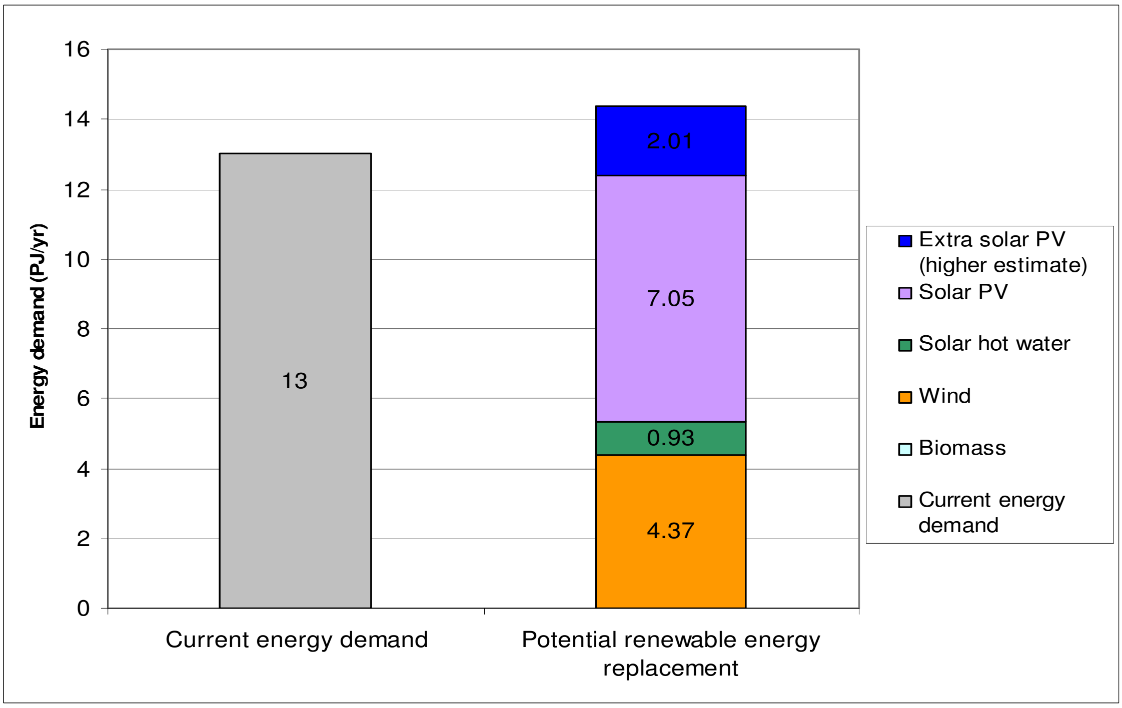

Figure 6: Comparison of current energy demand and potential renewable energy resource replacement for Manningham LGA.

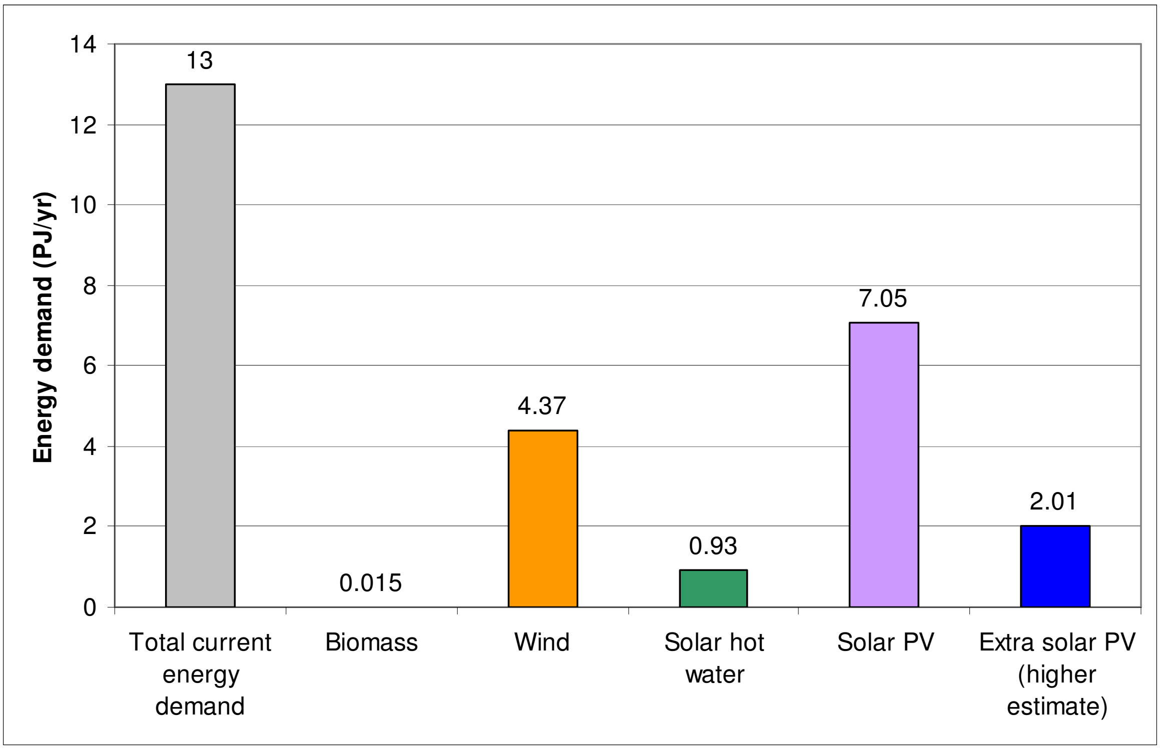

Figure 7: Comparison of current energy demand and a break down of the potential renewable energy resource replacement for Manningham LGA

Table 2: Breakdown of energy demand and renewable energy potential as a percentage of the current total energy demand for Manningham LGA.

	PJ/yr	% of Total
Total energy demand including transport	13.0	100
Total Energy Demand excluding transport	6.65	51
Solar PV	9.06 7.05*	70 54*
Solar hot water	0.93	7
Wind	4.37	34
Biomass	0.015	0.1
Total renewable energy resource	14.37 12.36*	110 95*
Remainder	+ 1.37 - 0.64*	10 -5*

*Using conservative calculation method.

The above results have presented the short-term resource potential, which is the renewable energy which can be collected using currently available technologies. The reserve, which is what can be economically produced based on current economic conditions, is presented below in Table 3 and Figure 8. It must be noted that this economic context may change considerably in the future which may improve the renewable energy reserve.

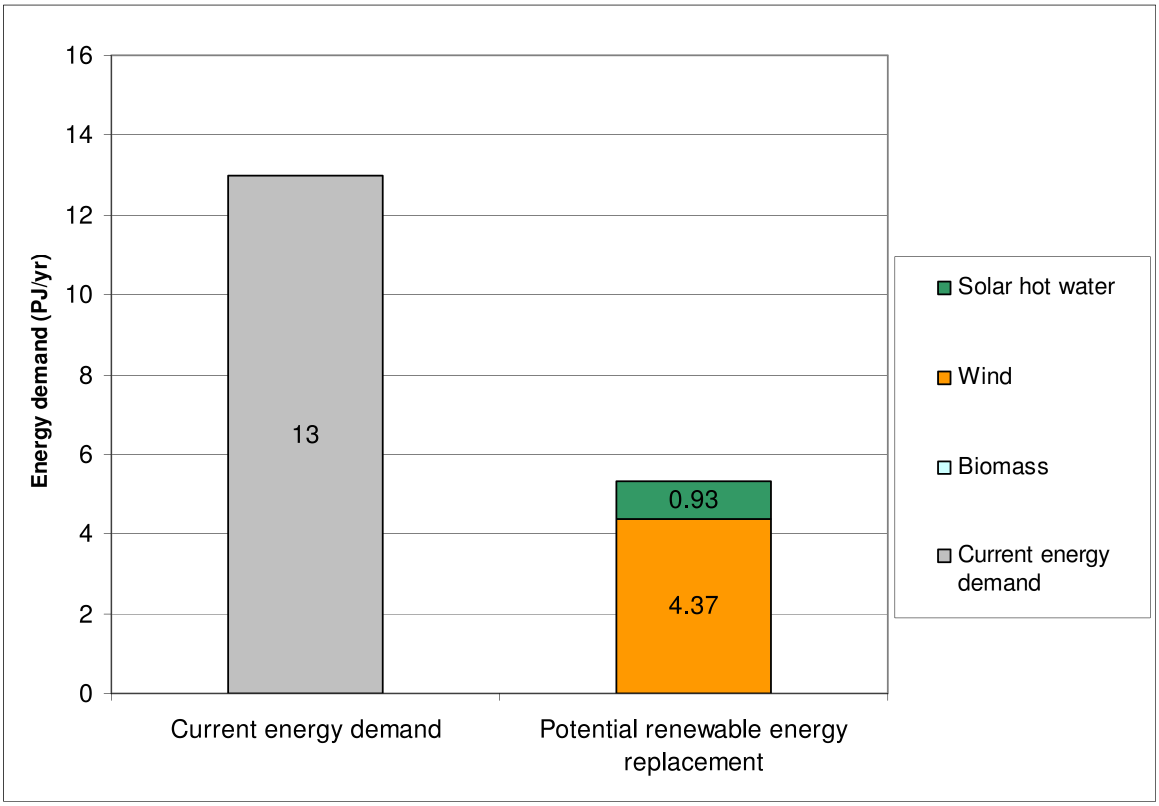

Figure 8: Comparison of current energy demand and potential renewable energy reserve replacement for Manningham LGA.

As can be seen in Figure 8 and Table 3, the reserve (what is currently economically available) is 5.32 PJ/yr which is about 41% of Manningham LGA's current energy demand. This drop from the renewable energy resource (what is available using current technologies), is due to the cost of solar PV currently being uneconomical when compared to current energy production (although this costing does not take into account environmental issues). The federal government currently offers a rebate for solar PV (maximum of $8000) which drops the cost of a 1kW solar PV system to around $8,000. Information from the Adelaide Solar Cities research has indicated that the price would need to drop to around $3,000 to become economically viable. If this was to occur in Manningham LGA, it would then allow for solar PV to be counted in the reserve. There has been some recent work in Manningham to provide a limited number of 1kW solar PV systems for around $2,000 which would make them economically viable.

If transport energy is taken out of the total energy demand for Manningham LGA, then the renewable energy reserve could produce around 80% of energy demand.

Table 3: Breakdown of energy demand and renewable energy reserve potential as a percentage of the current total energy demand for Manningham LGA.

	PJ/yr	% of Total
Total energy demand including transport	Average 13.0 (range 9.8 to 19.28)	100
Total Energy Demand excluding transport	Average 6.65 (range 11.77 to 4.7)	51
Solar PV	0	0
Solar hot water	0.93	7
Wind	4.37	34
Biomass	0.015	0.1
Total renewable energy resource	5.32	41
Remainder including transport	- 7.68	- 59

5 Discussion

This assessment into the potential for renewable energy in Manningham LGA has shown that depending on the assumptions made, there is enough renewable energy resource potential through wind and solar to meet current total energy demand based upon current technologies. If all the potential renewable energy options mentioned above were put in place, 4.32 Mt of carbon emissions would be saved or offset each year. Implementing just the economically viable renewable energy options (the reserve) would offset 1.83 Mt of carbon emissions each year.

It is currently economically viable to produce approximately 41% of total energy demand in Manningham LGA. As renewable energy technology decreases in costs, or if the cost of current energy increases, then this will increase the renewable energy reserve for Manningham LGA.

These calculations are based upon optimum operating conditions and in reality the potential may be slightly less. An example of this is that the solar energy calculations have not taken into consideration any potential shading from trees or nearby buildings and it assumes that each roof can collect at maximum capacity. The calculations used information based on current technologies. As technologies such as solar PV continue to improve and become more efficient, the energy output from these technologies will continue to increase, and new methods for collecting energy will continue to emerge.

Another issue to be considered is that the figures used for solar and wind are an average across several years and as such, some years may have lower or higher values which could alter the total energy output in any given year. Temporal issues of supply and demand across shorter timeframes (eg. Night and day) have also not been considered in this study.

There is potential to utilise these renewable energy technologies in methods that have not been looked at here, such as putting solar panels on top of street lights and electronic. These methods would provide extra renewable energy although the main methods as described throughout this report are expected to provide the majority of the renewable energy potential.

The results for wind and biomass energy could potentially increase in the future with improved technology, new facilities in the LGA and a more in-depth survey. Large wind turbines were found to not have any potential sites in this assessment, however a specific wind survey may find there are suitable locations. The potential for biomass to provide more renewable energy would increase if waste disposal and recycling was done at a facility within the Manningham LGA region so that biomass energy could be collected and used.

It should also be noted that when the term 'financially viable' or 'economically viable' is discussed throughout these results, it refers to the cost from the end users perspective and does not from society's perspective (which would take into account environmental and social benefits as well as the straight out economic cost comparisons).

6 Conclusion

Manningham LGA currently uses 13 PJ/yr of energy, of which renewable energies could produce 95% of the total (using conservative calculations). This would save approximately 4.3 Mt of carbon emissions each year. This investigation into the potential for renewable energy technologies within Manningham LGA has shown what is possible if Manningham wants to move towards maximising renewable energy.

While it is important for energy use to move towards being produced by renewable energy methods, it is also important to consider with any future planning for renewable energy the need to increase energy efficiency and reduce total energy use across all sectors of life. By increasing energy efficiency and reducing total energy use this will in turn lead to less renewable energy being required to meet total energy demand.

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